Muons, Inc. High Pressure RF Cavity Results at the MTA

Pierrick Hanlet
Muons, Inc.

M.Alsharo'a, P.Hanlet, R.Hartline, R.Johnson, M.Kuchnir, K.Paul, K.Yonehara
Muons, Inc.

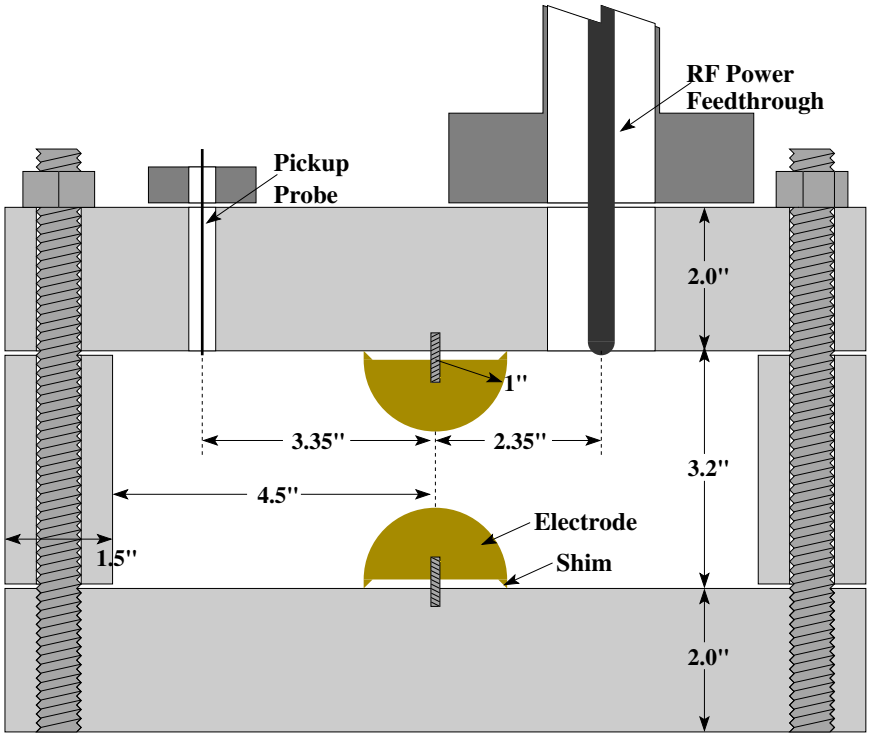
C.Ankenbrandt, A.Moretti, M.Popovic
Fermilab

D.Kaplan
Illinois Institute of Technology

Muons, Inc. High Pressure RF Cavity Results at the MTA

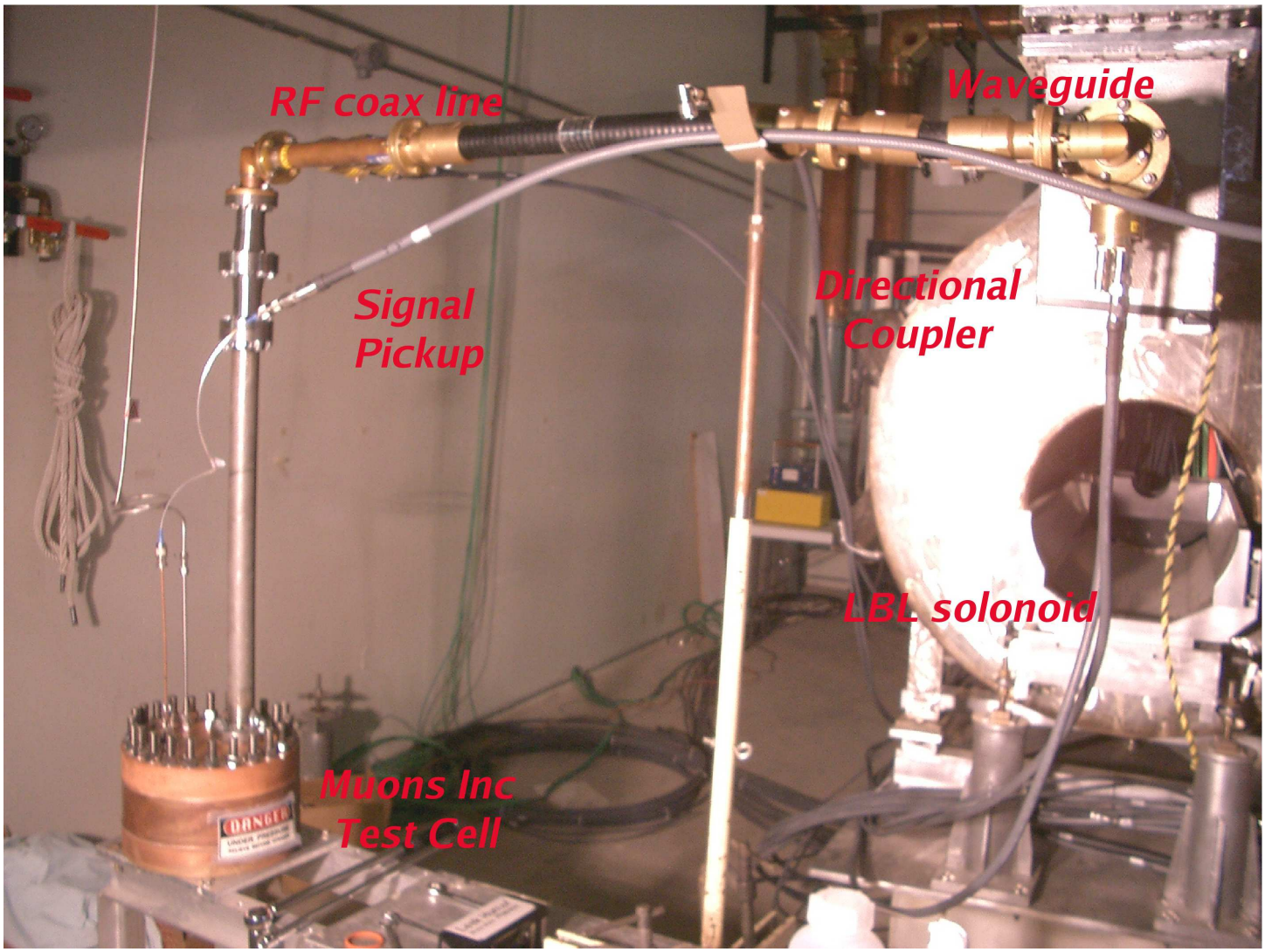
A muon collider (or neutrino factory), requires rapid cooling *and* acceleration of muons:

- **high gradient for rapid acceleration**
- **RF cavities in close proximity to magnetic fields for shorter channel**



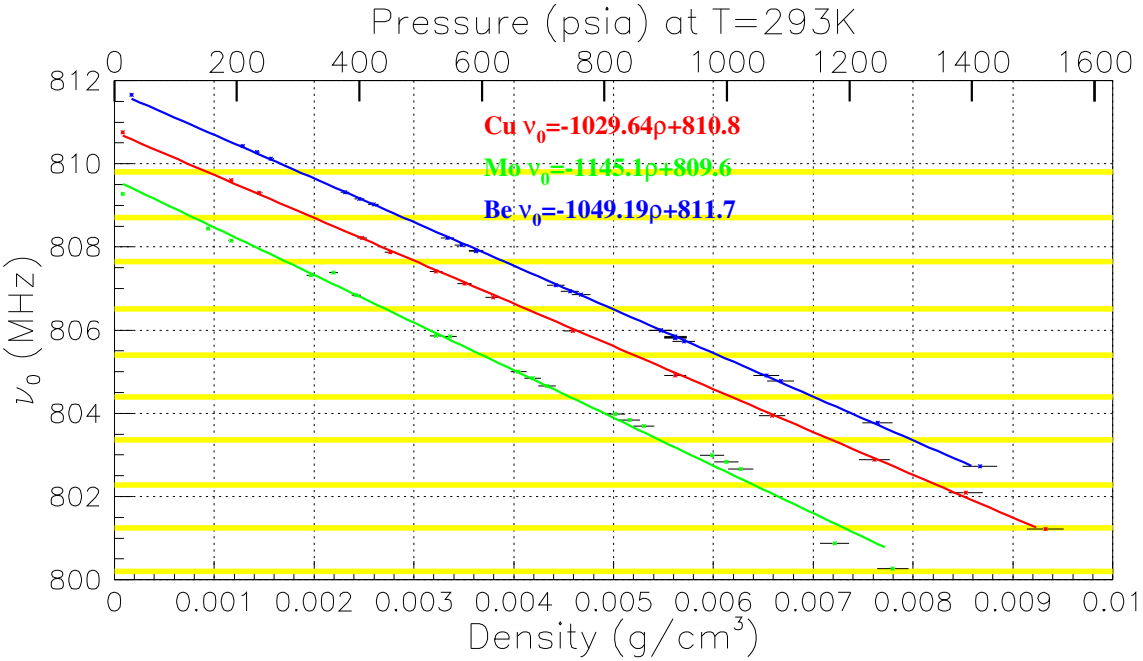
- **Material breakdown studies**
- **Magnetic field - operate cavity inside solenoidal field**
- **Beam - operate cavity with high intensity beam**

MTA High Pressure RF Studies



Measurement Procedure for High Pressure RF Studies

- measurements made for Cu (red), Mo (green), and Be (blue)
- yellow bars indicate frequencies to avoid
- Procedure:
  - condition cavity $\sim 3hours$!!!
  - set gas pressure and adjust klystron frequency to find ν_0
  - ramp klystron power until breakdown occurs
  - ramp down klystron power until stable
  - measure voltage from pickup (also from directional coupler)



Corrections and Calibration

- **Corrections**
  - Measure cable insertion losses
  - Measure cavity properties with network analyzer
  - Correct for cable losses
  - Correct for gas density dependence

- **Calibration**
  - Use SuperFish/Ansys to determine calibration constants

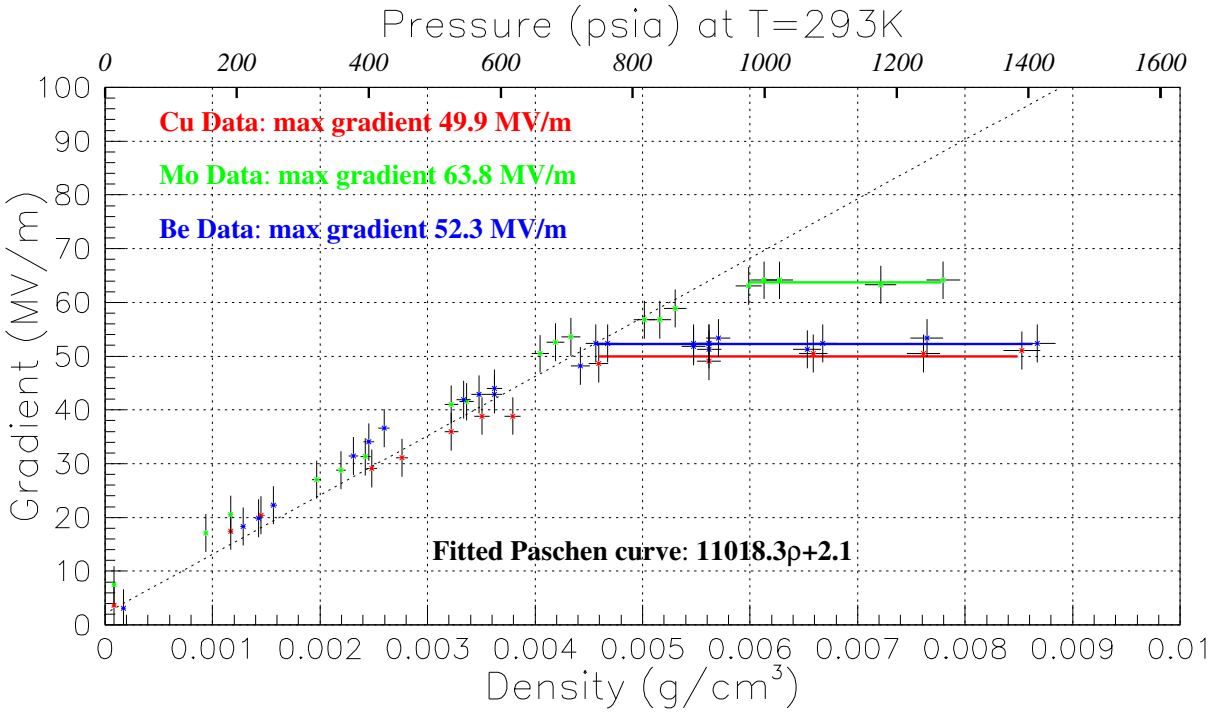
Since

$$\frac{E_m}{\sqrt{P_m}} = \frac{E_{SF}}{\sqrt{P_{SF}}} \quad \longrightarrow \quad E_m = E_{SF} \cdot \sqrt{\frac{P_m}{P_{SF}}} \tag{1}$$

However, since SuperFish assumes a perfect cavity, P_{SF} must be corrected by the ratio of measured Q_0 to Q_{SF}, as before. Such that:

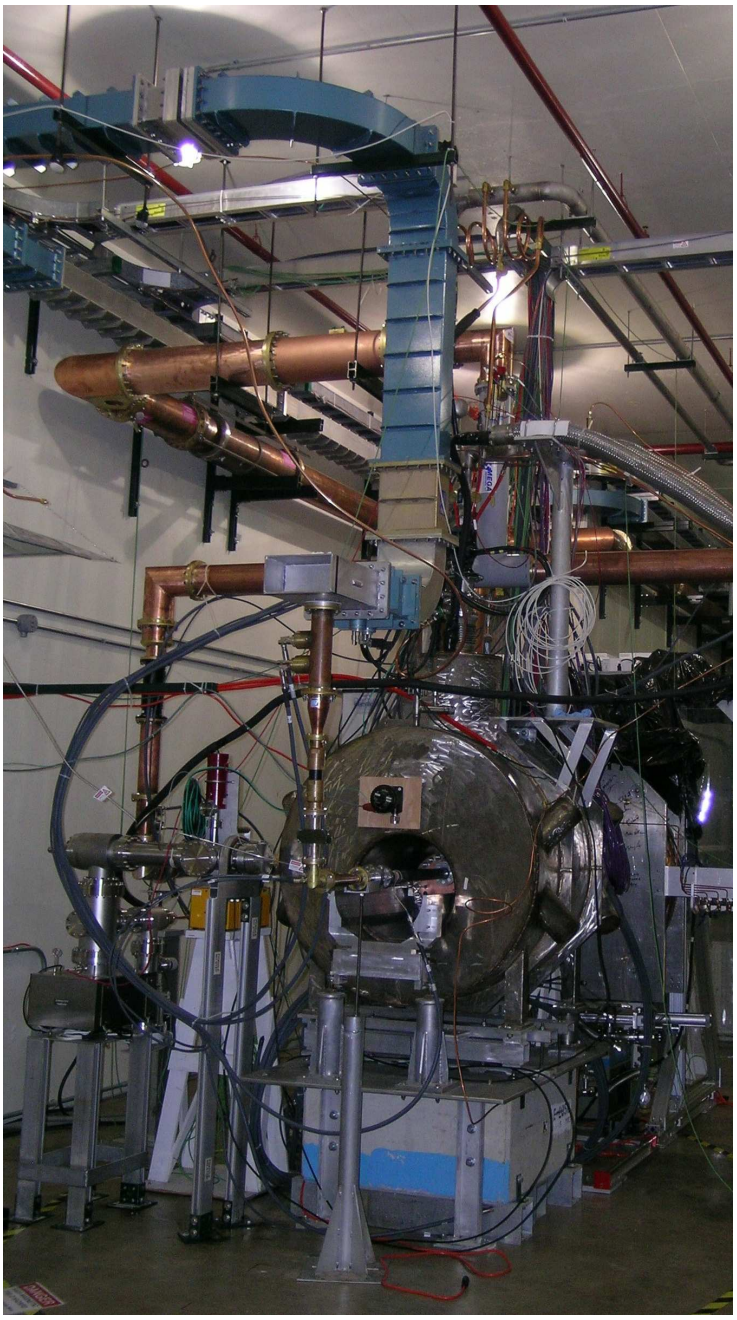
$$E_m = E_{SF} \cdot \sqrt{\frac{P_m}{P_{SF}}} = E_{SF} \cdot \sqrt{\frac{P_m \cdot Q_L \left(1 + \frac{R_m}{50\Omega}\right)}{P_{SF} \cdot Q_{SF}}} \tag{2}$$

Preliminary High Pressure RF Study Material Results

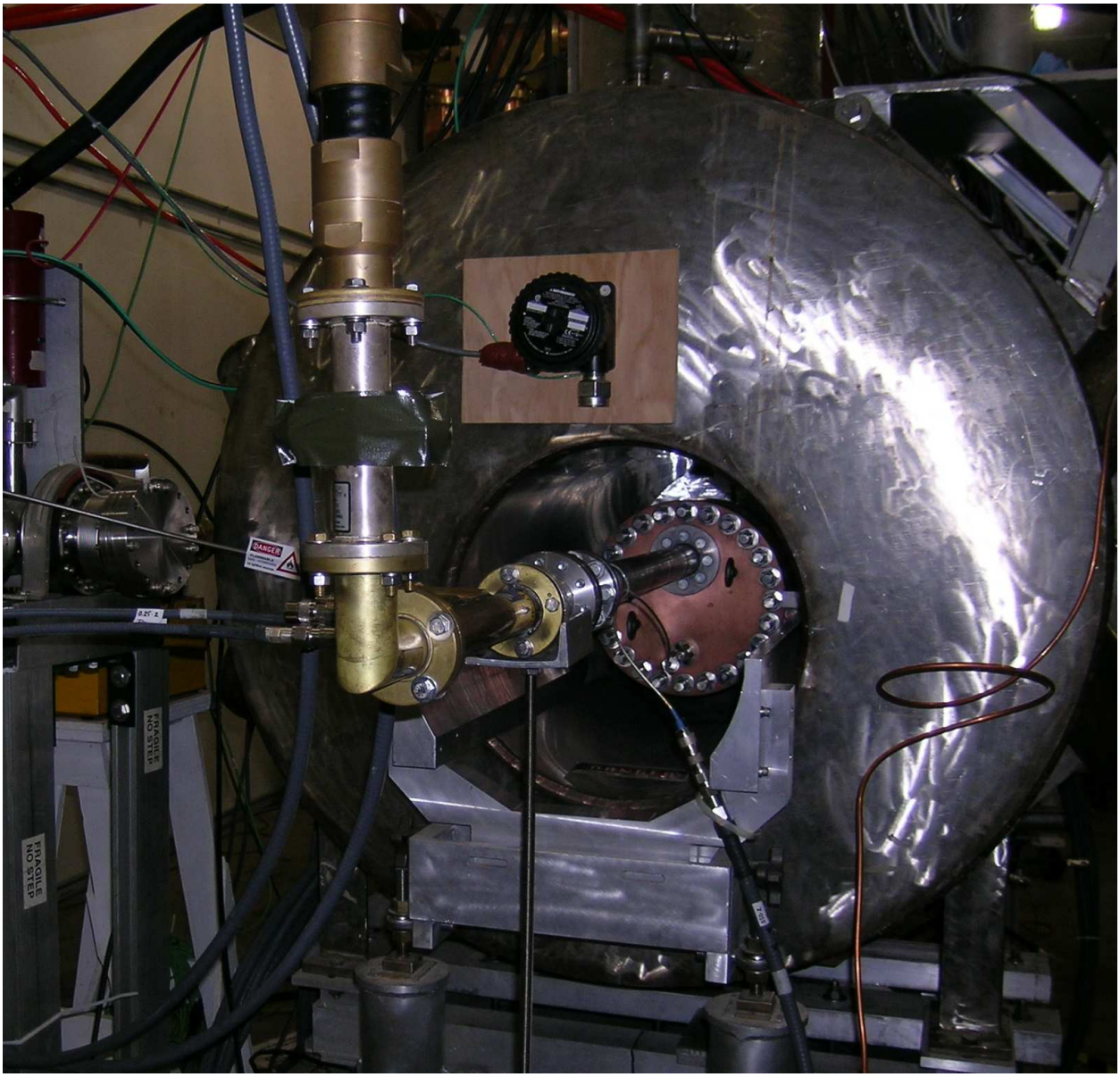


- **Cu: Maximum gradient is 49.9 MV/m**
- **Mo: Maximum gradient is 63.8 MV/m**
- **Be: Maximum gradient is 52.3 MV/m**

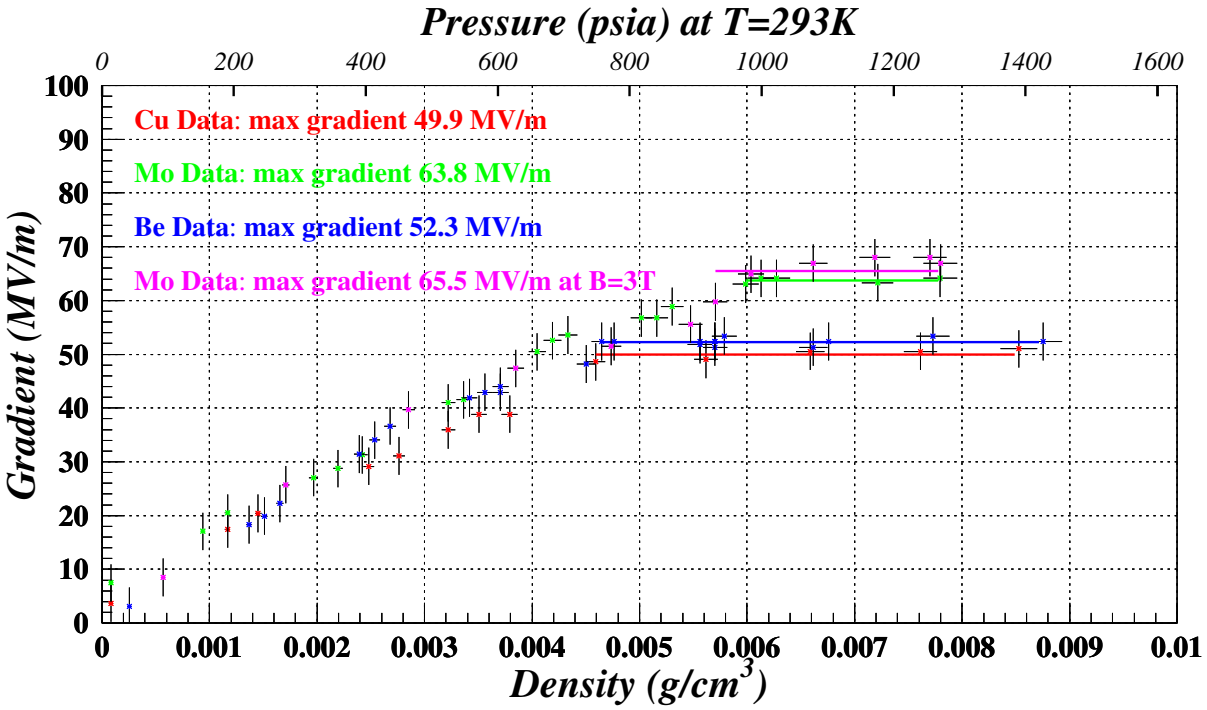
Measurements in Magnetic Field



Measurements in Magnetic Field

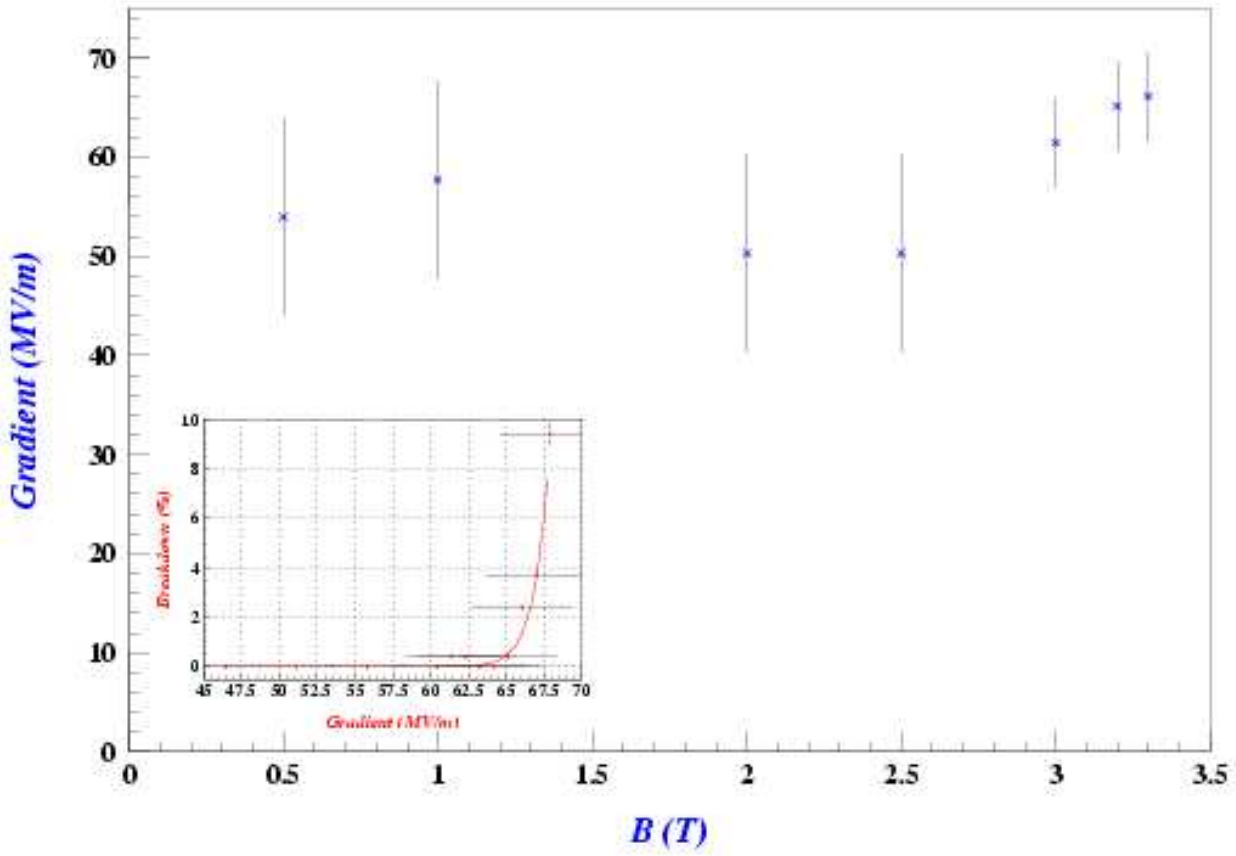


Preliminary High Pressure RF Study Magnetic Field Results



Mo: Maximum gradient is 65.5 MV/m

Preliminary High Pressure RF Study Magnetic Field Results



No degradation over range of magnetic field

Next Steps

- **More materials – W may yield** $\sim 95 MV/m$
- **Measurements with beam**
- **Measurements with beam** *and* **Magnetic field**